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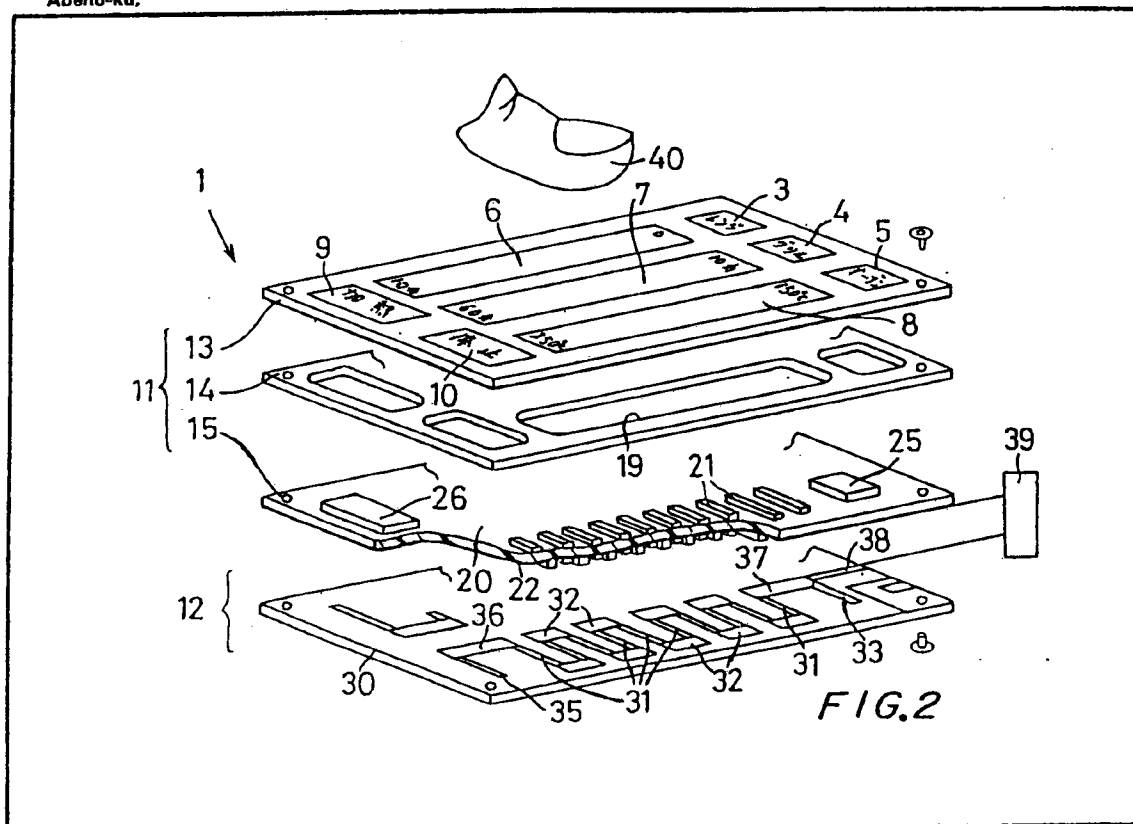
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(54) Membrane keyboards

(57) A membrane keyboard is used in a microwave oven or other household appliance for introducing a setting into the appliance through simple and one-touch actuation. The keyboard includes a flexible sheet 15 having a

plurality of elongated actuator pushers 21 on a surface thereof and carrying on an opposite surface a contact foil 22 or a plurality of first contacts on the foil 22 aligned with the actuator pushers 21, a substrate 30 having a plurality of second contacts 31 aligned with the actuator pushers 21, the contacts being brought into electric contact either directly or via a pressure sensitive conductive rubber member when one of the actuator pushers 21 is depressed. The second contacts 31 are connected together by high resistance conductors 32. When one of the pushers 21 is actuated, the resistance between the connected contacts 31 and the foil 22 is sensed by a computer 39 to determine the actuated position.



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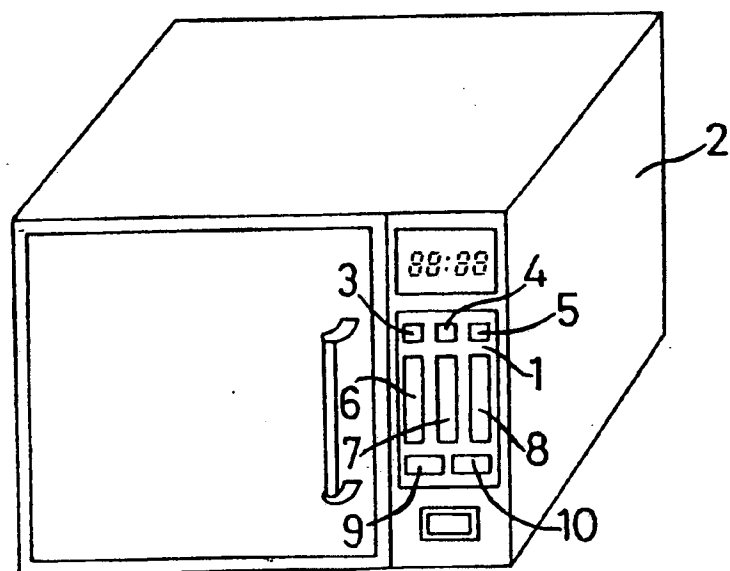
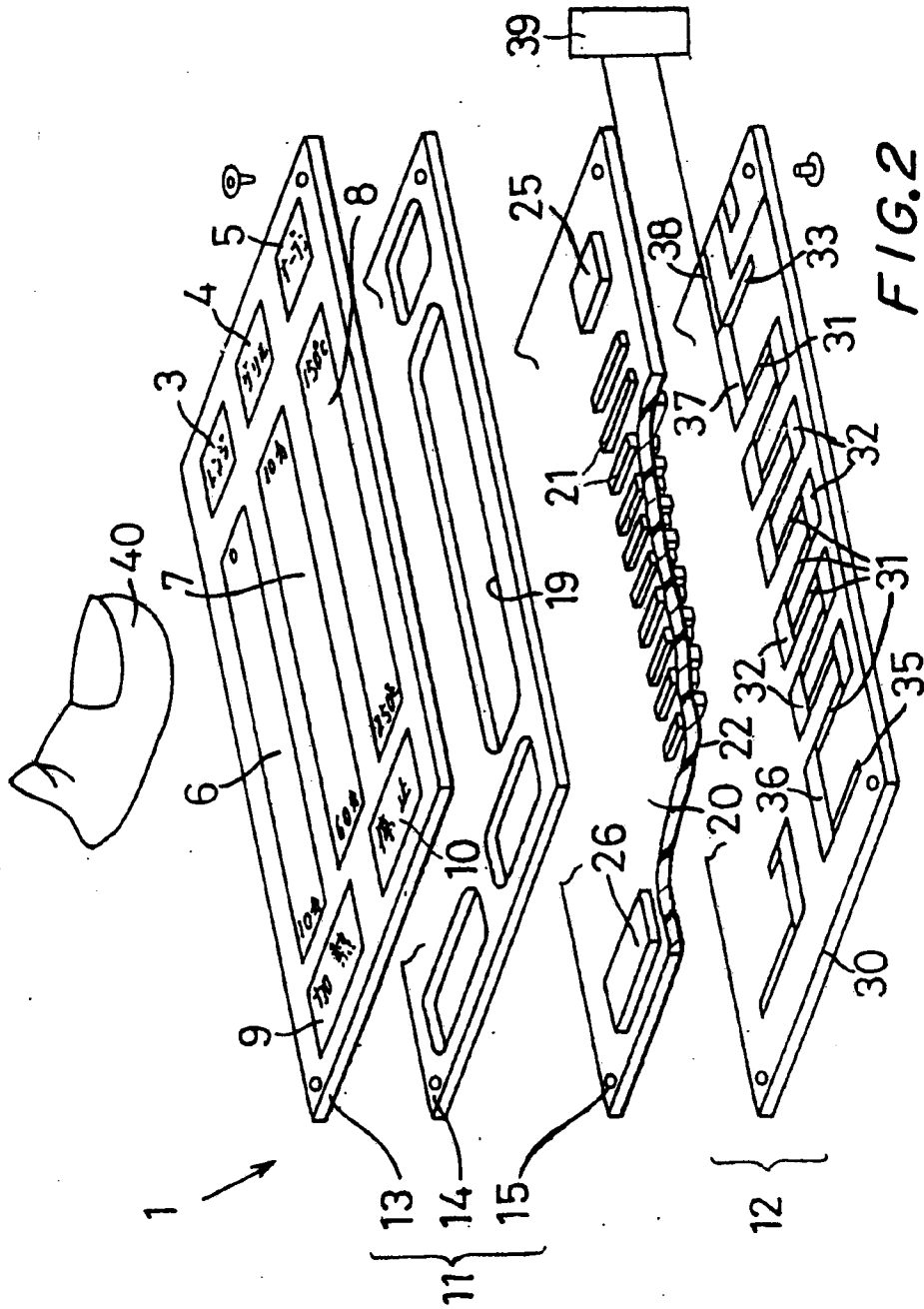


FIG. 1





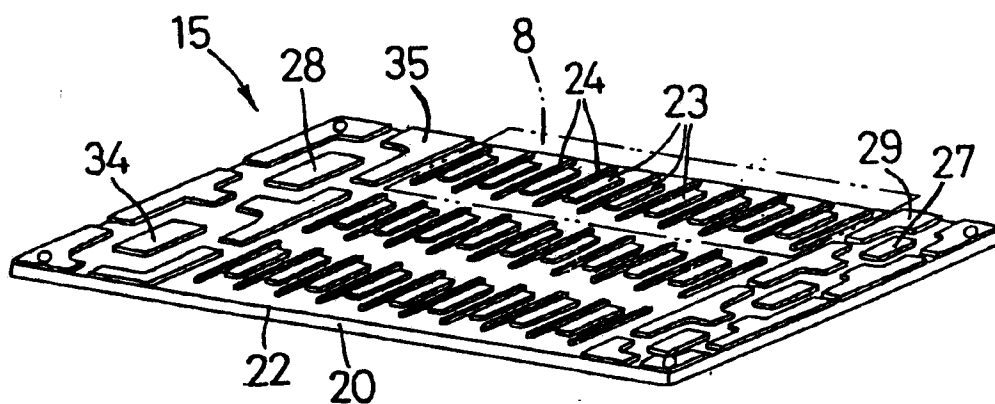


FIG. 4

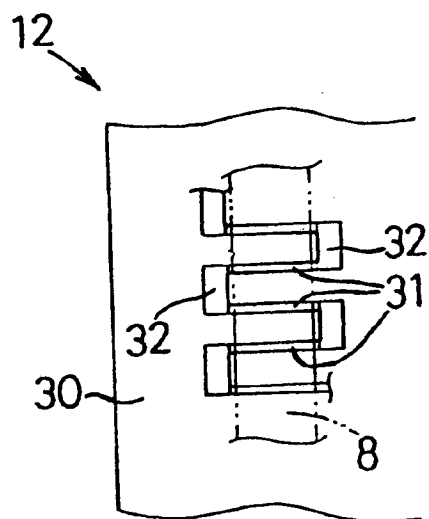


FIG. 5

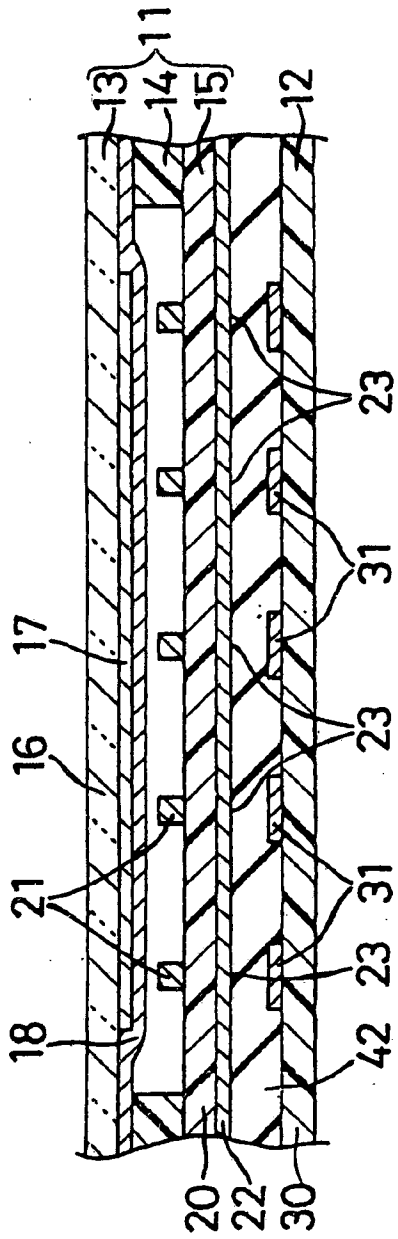


FIG. 6

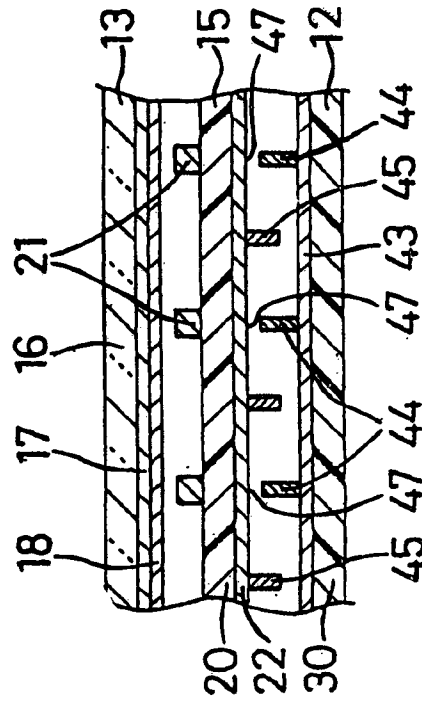


FIG. 7

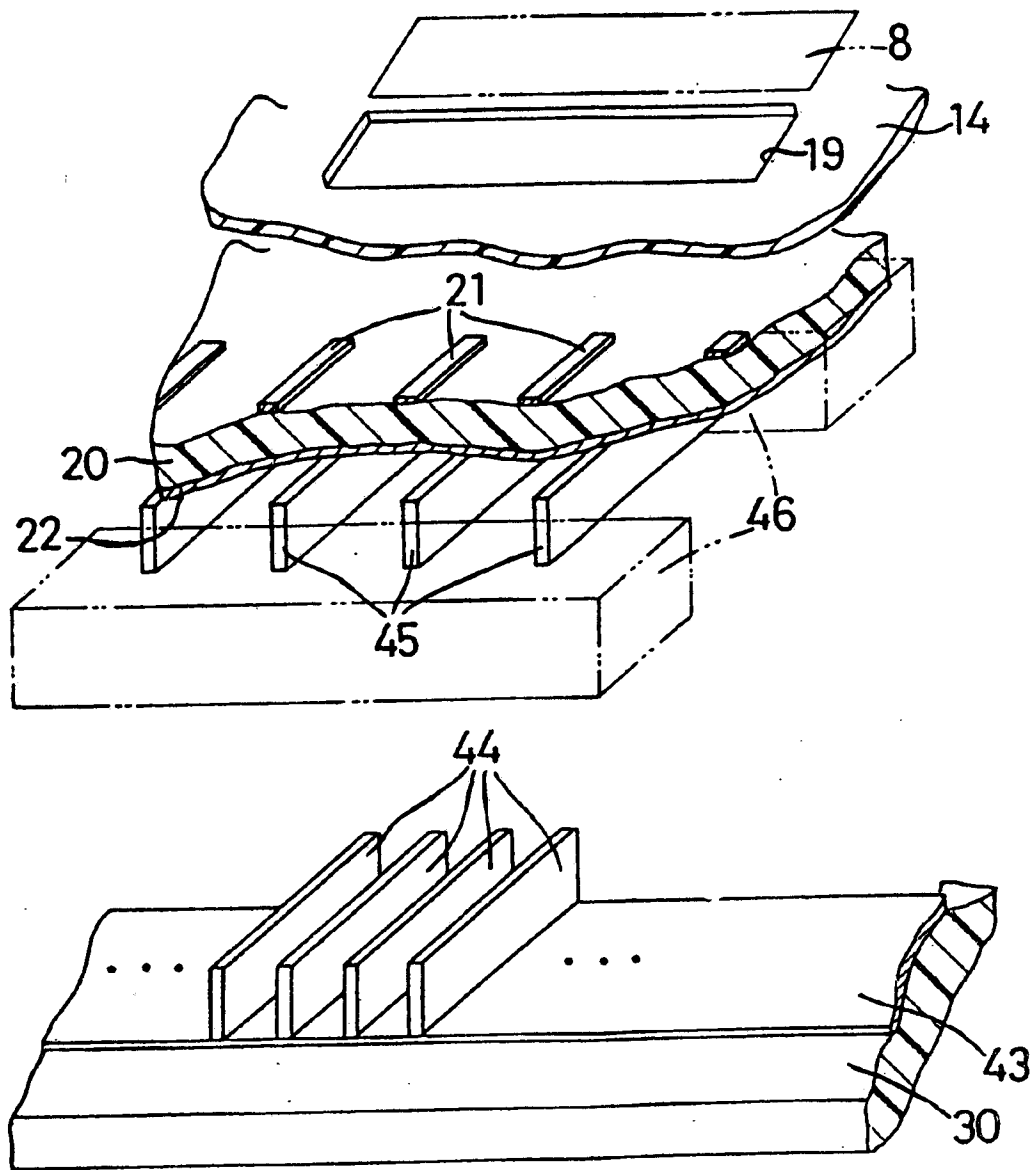
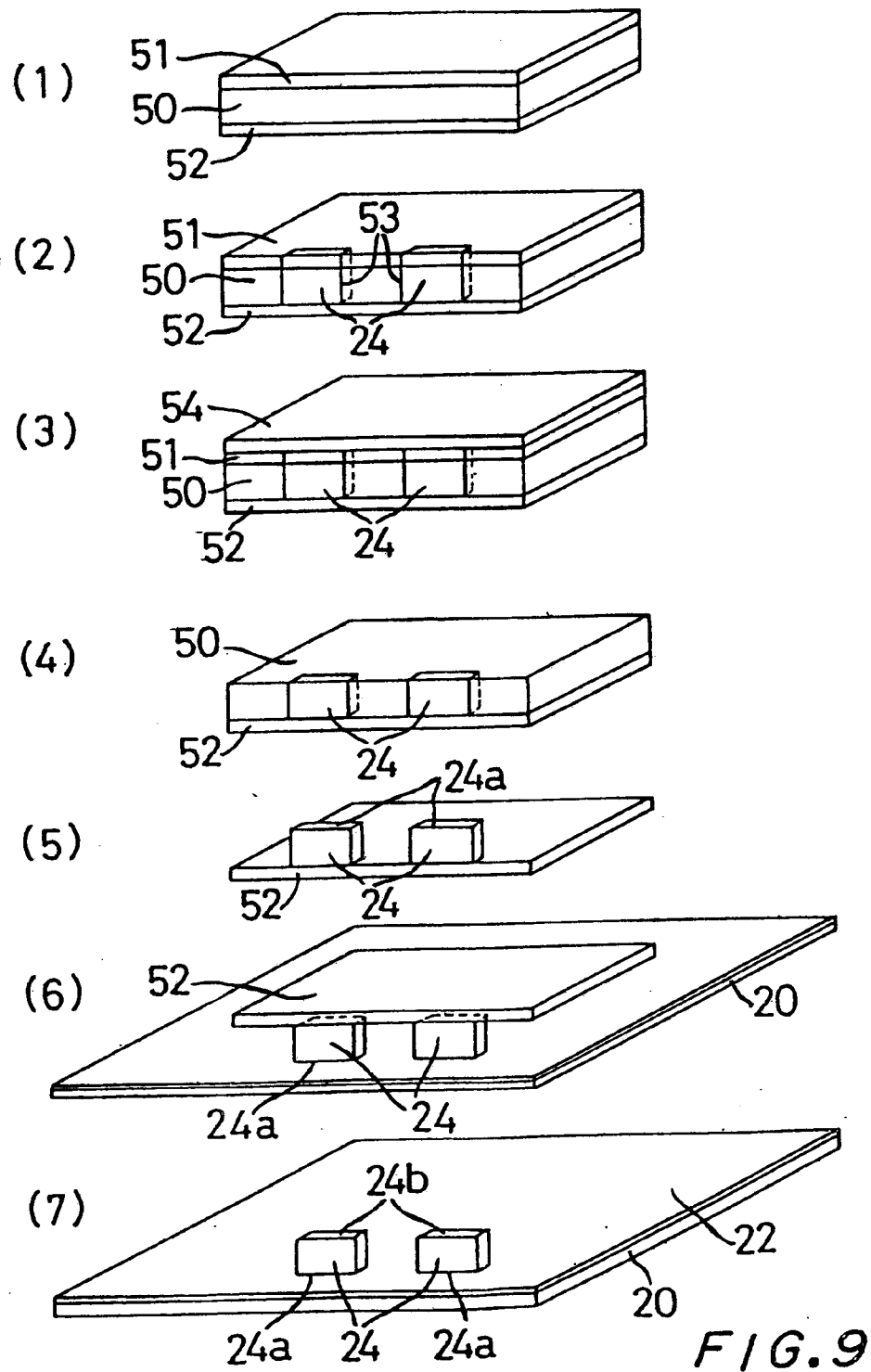


FIG. 8

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## SPECIFICATION

### Keyboard of the membrane type

#### Background of the invention

5 This invention relates to an input device, and more particularly it relates to a membrane type input device for introducing electric signals into a microcomputer-based circuit or other circuits.

To achieve a wide range of various functions of household appliances including microwave ovens, 10 microcomputers are in increasing use and a number of key switches, variable resistors of the rotary type or the slide type and so forth are used in conjunction with those microcomputers for introduction of electric signals thereto. The 15 variable resistor is more advantageous than the key switches in entering numerical representations of heating parameters such as time and temperature because the former demands merely selecting of a desired resistance value while the latter needs actuations of a 20 desired number of the key switches. Even though being advantageous in the above aspect, the variable resistor has the inherent disadvantages that structure is complex and costly and its 25 protruding knob is difficult to clean. The last problem is critical especially for use in microwave ovens which should be constantly kept clean.

#### Object and summary of the invention

30 Accordingly, it is an object of the present invention to provide an electric signal input device which is capable of introducing a number of information bits selectively through simple operation and a minim of expenditures.

To accomplish the above mentioned object, the 35 present invention provides an electric signal input device which comprises an actuator means composed of a generally flat plate having a plurality of elongated actuator sections on a surface thereof and carrying a plurality of first 40 electrodes disposed wholly through an opposite surface thereof and facing against said plurality of the actuator sections, a substrate disposed in conjunction with said actuator means and having a plurality of second electrodes each 45 corresponding to each of said first electrode, said first and second electrodes are brought into electric contact when the corresponding one of said actuator sections is depressed and become bent, and means for sensing where said first and 50 second electrodes are in electric contact along the length of said actuator sections.

Therefore, the input device includes the elongated array of the first electrodes disposed along the opposite surface of the actuator means 55 also carrying the corresponding number of the actuator sections and the elongated array of the second electrodes disposed on the substrate each in opposing relationship with the respective one of said first electrodes so that an electric signal 60 descriptive of where the first and second electrodes are brought into electric contact may be derived through only one depression of the corresponding one of the actuator sections. A

number of information bits may be therefore 65 selectively introduced through simple operation. Further, the input device embodying the present invention is simpler in structure than the conventional variable resistor of the rotary or slide type. The actuator means is flat and easy to clean 70 and useful widely for home appliances where cleanliness is of importance.

#### Brief description of the drawings

For a more complete understanding of the present invention and for further objects and 75 advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of a cooking 80 appliance having a built-in electric signal input device constructed according to an embodiment of the present invention;

Fig. 2 is an exploded perspective view of the electric signal input device;

Fig. 3 is a cross-sectional view of the electric 85 signal input device shown in Fig. 2;

Fig. 4 is a perspective view of the electric signal input device while viewed from back;

Fig. 5 is a partially plan view of an electrode 90 sheet 15;

Fig. 6 is a cross-sectional view of another 95 embodiment of the present invention;

Fig. 7 is a cross-sectional view of still another embodiment of the present invention;

Fig. 8 is a partially exploded perspective view 100 of the electric signal input device as illustrated in Fig. 7; and

Fig. 9 is a perspective view for explanation of the procedure by which spacers 24 are disposed on a protective film 20.

#### Detailed description of the invention

Referring now to Fig. 1, there is illustrated a perspective view of a cooking appliance 2 having a built-in electric signal input device 1 105 constructed according to an embodiment of the present invention. The electric signal input device 1 has an actuator region 3 for selection of microwave or dielectric heating of food, an actuator region 4 for selection of grill heating as necessary in simmering food and an actuator 110 region 5 for selection of oven heating as in browning food. Further disposed below those actuator region 3 to 5 are an actuator region 6 for setting microwave heating time, an actuator region 7 for setting grill heating time and an 115 actuator region 8 for setting oven heating temperature, all of which are designed according to the present invention. An actuator region 9 is depressed when food is to be heated and an actuator region 9 is depressed when heating is to 120 stop. Electric signals from the electric signal input device 1 are introduced into a microcomputer 39 (see Fig. 2) contained in the appliance 2 for controlling heating of food.

Fig. 2 is an exploded perspective view of the 125 electric signal input device 1 and Fig. 3 is a longitudinal cross-sectional of the input device 1.

The electric signal input device 1 generally includes an actuator member 11 and a substrate 12 disposed behind the actuator member 11. The actuator member 11 is made of a flexible and elastic plate with a generally flat laminated structure which includes a cover sheet 13, a spacer 14 and an electrode sheet 15. The cover sheet 13 includes a transparent plastic film 16 carrying on its rear surface indicia 17 characteristic of the actuator region 8 as formed by printing of elastic ink or adhering. An aluminum foil 18 is adhered, printed, deposited or otherwise in such a manner as to screen the film 16 and the indicia 17.

The spacer 14 is made of electrically insulating plastic material having punched or perforated portions corresponding to the respective actuator regions 3 to 10. When a particular one of the actuator regions is not actuated, the spacer 14 keeps its associated pusher or pushers 21 out of the aluminum foil 18 and holds the film 16 flat. It is understood that the actuator regions 6 to 8 extend along the vertical direction of the cooking appliance 2.

The electrode sheet 15 includes a protective film 20 typically of electrically insulating and flexible plastic material. On a surface of the protective film 20 facing against the cover sheet 13 there are equally spaced and aligned a plurality of the pushers 21 along the length of the actuator region 8. The pushers are made of plastic material having a rigidity high enough not to collapse when being depressed by the operator's finger. An aluminum foil 22 is adhered, deposited, printed or otherwise entirely on the opposite surface of the protective film 20 adjacent the substrate 12.

Fig. 4 is a perspective view of the electrode sheet 15 as viewed from the substrate side 12. On the aluminum foil 22 there is a plurality of first electrodes aligned at a given interval along the length of the actuator region 8, which electrodes are typically made of electrically conductive material with low resistance such as carbon. These electrodes may be disposed by painting, printing or other conventional manners. The first electrodes 23 are located beneath the respective pushers 21. Spacers 24 typically of electrically insulating material such as plastic are interposed between the two adjacent first electrodes 23 along the length of the actuator region 8. The spacers 24 extend along the width of the actuator region 8 and have a rigidity high enough not to collapse when being depressed. In conjunction with the remaining actuator regions 6 and 7, the pushers 21, the first electrodes 23 and the spacers 24 are provided in a likewise manner. To set up the actuator regions 5 and 9, pushers 25 and 26 are mounted on the protective film 20 of the electrode sheet 15 and electrodes 27 and 28 are disposed beneath the pushers 25 and 26 together with spacers 29 and 35. The architecture of the remaining actuator regions 3 and 4 are similar to that of the actuator region 5 and the architecture of the actuator region 10 is

similar to that of the actuator region 9. An electrode 34 corresponds to the actuator region 10. The spacers 24 have a thickness greater than the sum of the thicknesses of the first electrodes 23 and second electrodes 31 described hereinafter so that the first and second electrodes 23 and 31 may be kept in non-contacting relationship when a particular one of the actuator regions is not actuated.

The substrate 12 is disposed face-to-face with the actuator member 11. On a support film 30 typically of an electrically insulating plastic material there is disposed a plurality of the second electrodes 31 typically of conductive material such as carbon by painting, printing or other conventional manners. The respective ones of the second electrodes 31 are aligned along the length of the actuator region 8 to correspond to the respective ones of the first electrodes 23. The second electrodes 31 are connected in a serpentine fashion by means of conductors 32 which are formed of electrically conductive material such as carbon and disposed on the support film 30 by painting, printing or other conventional manners.

Fig. 5 is a plan view of a portion of the substrate 12 carrying the second electrodes 31 and the conductors 32. The second electrodes 31 have a low resistance and the conductors 32 have a high resistance. It is preferred that the transparent film 16, the protective film 20 and the support film 30 be made by materials having substantially the same coefficient of thermal expansion, e.g. polyester and polyvinyl chloride.

An electrode 33 is provided in connection with the electrode 27 in the actuator region 5 and an electrode 35 is provided which may come into contact with the electrode 34 in the actuator region 10. The second electrodes 31 are connected to the electrode 33 by way of a conductor 37 having a high resistance. Further, the second electrodes 31 are connected to the electrode 35 by way of a conductor 36 having a high resistance. The resistance extending between a terminal 38 leading from the second electrodes 31 and the electrodes 33 and 35 connected via the conductors 32, 36 and 37 and the aluminum foil 22 is sensed by a microcomputer 39 which governs heating operation of the cooking appliance. If any one of sections in the actuator region 8 along its length is depressed by the finger 40, then the cover sheet 13 depresses selectively the corresponding one of the pushers 21 so that the first electrode 23 beneath the depressed one of the pushers 21 comes into contact with the second electrode 31. The resistance between the terminal 38 and the aluminum foil 22 is lower when the pair of the first and second electrodes 23 and 31 near the terminal 38 are in contact with each other and higher when the first and second electrodes remote from the terminal 38 are in contact. With such measurements of the resistance, it is possible to detect the finger-actuated position along the length of the actuator region 8. It is

therefore possible to select a heating temperature along the length of the actuator region 8 and introduce selectively the temperature for the cooking appliance. Whether the electrodes 27 and 33 and the electrodes 28 and 35 are in contact is decided in a similar manner.

The spacers 24, 29 and 35 mounted on the electrode sheet 15 are islands with no closed space and spaces 41 (see Fig. 3) defined by the electrode sheet 15 and the substrate 12 are open to the atmosphere. This leads to certainty that the first electrodes 23 are brought into contact with the second electrodes 31.

Fig. 6 is a sectional view similar to Fig. 3 but shows another embodiment of the present invention. This alternative embodiment is analogous to the above illustrated embodiment and components similar to those in the previous embodiment are represented by the same reference numbers. Attention is invited to the provision of a pressure-sensible conductive rubber member 42 interposed between the aluminum foil 22 secured on the protective film 20 of the electrode sheet 15 and the substrate 12. The pressure-sensible conductive rubber member 42 has elasticity and the electric property that its local resistance becomes lower when being depressed. The pressure-sensible conductive rubber member 42 may be set up by a composite including 6 weight parts of neoprene rubber and 4 weight parts of conductive material powders such as silver powders. Respective portions of the aluminum foil 22 immediately above the second electrodes serve as the first electrodes 23. When the actuator region 8 is depressed in part by the finger, the portion of the aluminum foil 22 right below the finger-depressed portion depresses and deforms as the first electrode the pressure-sensible rubber member 42 and moves the deformed portion of the rubber member close to the second electrode 31 so that a path is bridged with a low value of resistance between the aluminum foil 22 and the second electrode 31. Provided that the resistance between the aluminum foil 22 and the terminal 38 (see Fig. 2), it is possible to sense the finger-actuated position along the length of the actuator region 8.

Fig. 7 is a cross-sectional view of still another embodiment and Fig. 8 is a partially exploded perspective view. This embodiment is analogous to the previous embodiment but is featured by that an elongated, strip-like electric conductor 43 of high resistance carbon or other similar electric conductive material is painted, printed or otherwise disposed on the support film 30 on the substrate 12 and a predetermined number of second electrodes 44 of a low resistance are set up on the conductor 43 and equally spaced along the length of the actuator region 8. As described previously, the aluminum foil 22 is adhered on the protective film 20 of the electrode sheet 15 and a predetermined number of contactors 45 are mounted on the aluminum foil 22 in such a manner as to direct toward the substrate 12. On

the aluminum foil 22 there is further disposed a spacer 46 which keeps the second electrodes 44 away from the aluminum foil 22 and the contactors 45 away from the conductor 43 when any section of the actuator region is not actuated. Upon actuation of any one of the sections of the actuator region 8 the second electrode 44 comes into contact with the portion of the aluminum foil 22 which serves as the first electrode 47 immediately above the second electrode 44. The resistance extending between the aluminum foil 22 and one end of the conductor 43 varies as a function of the position where an electrical contact is set up. The contactors 45 may also come into contact with the conductor 43.

Referring to Fig. 9, there is illustrated the procedure by which the spacers 24 are disposed and aligned on the aluminum foil 22 on the protective film 20. As seen in Fig. 9(1), an adhesive is applied to both surfaces of a film 50 forming the spacers 21 and strip sheets 51 and 52 are adhered thereon. When the strip sheets 51 and 52 are removed, the adhesive remains on the film 50 with which the film 50 may be adhered in the following manner. Slits 53 are defined in the strip sheet 51 and the film 30 by means of a Thomson model or the like as shown in Fig. 9(2). It is noted that the slits 53 are formed in the strip sheet 52. A sheet 54 with an adhesive applied thereon is secured on a surface of the strip sheet 51 with the aid of the adhesive on the sheet 54 as seen in Fig. 9(3). Thereafter, the sheet 54 and the strip sheet 51 are peeled off at a time. The result is illustrated in Fig. 9(4). Provided that the film 50 is removed from the strip sheet 52, the insulator islands 24 remain on the strip sheet 52 as seen in Fig. 9(5), with the adhesive on the summits 24a thereof. While the strip sheet 52 is held with top down, the summits 24a are adhered on the aluminum foil 22 on the protective film 20 of the electrode sheet 15. Fig. 9(7) shows the situation after the strip sheet 52 has been removed, wherein the spacers 24 are equally aligned on the aluminum foil 22. The bottom surfaces 24b of the spacers 24 opposite the summit surfaces 24a are fixedly secured on the support film 30 by means of the adhesive remaining on the bottom surfaces 24b.

Although in the above illustrated embodiments the second electrodes 31 are connected in series by means of the conductors 32, it is obvious to those skilled in the art that electric signals are introduced into the microcomputer 39 by way of individual lines leading to the respective ones of the second electrodes 31. The cover sheet 13 may be made of a single flexible film or the indicia may be printed or otherwise disposed on the foil for the actuator regions 3 to 10.

While only certain embodiments of the present invention has been described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit and scope of the invention as claimed.

**Claims**

1. An electric signal input device comprising:  
an actuator means composed of a generally  
flat plate having a plurality of elongated actuator  
sections on a surface thereof and carrying a  
plurality of first electrodes disposed wholly  
through an opposite surface thereof and facing  
against said plurality of the actuator sections;  
a substrate disposed in conjunction with said  
actuator means and having a plurality of second  
electrodes each corresponding to each of said  
first electrode, said first and second electrodes are  
brought into electric contact when the  
corresponding one of said actuator sections is  
depressed and become bent; and  
means for sensing where said first and second  
electrodes are in electric contact along the length  
of said actuator sections.
2. An electric signal input device according to  
claim 1 further comprising a spacer means for  
keeping said first electrodes away from said  
second electrodes when the actuator sections are  
not actuated.
3. An electric signal input device according to  
claim 2, wherein said spacer is of a thickness  
greater than the sum of the thicknesses of said  
first and second electrodes for keeping said first  
and second electrodes in non-contacting  
relationship.
4. An electric signal input device according to  
claim 1, wherein said first electrodes are movable  
and finger-actuable and said second electrodes  
are stationary and said second electrodes are  
connected in electric serial fashion with the  
intervention of a resistance.
5. An electric signal input device according to  
claim 1, wherein said first electrodes are made of  
pressure-sensible material.
6. A manually-operable electrical input device  
comprising first and second electrodes which face  
each other and one of which can be brought  
closer to the other in any of a number of different  
regions by pressure applied to a selected one of a  
number of different positions on a substantially  
flat surface of the device, and means coupled to  
said electrodes and operable to determine from  
the change in electrical properties therebetween  
which of said positions has had pressure applied  
thereto.
7. An input device substantially as herein  
described with reference to any of the  
accompanying drawings.